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# Indian Ocean Dipole

**Published On: 28-06-2023**

## Why in News:

With the El Nino phenomenon almost certain to affect the Indian monsoon this year, high hopes are pinned on the development of a positive Indian Ocean Dipole (IOD) and its ability to counterbalance the El Nino effect.

## About IOD

The IOD is an ocean-atmosphere interaction very similar to the El Nino fluctuations in the Pacific Ocean, playing out, as the name shows, in the Indian Ocean. It is also a much weaker system than El Nino, and thus has relatively limited impacts.

But a positive IOD does have the potential to offset the impacts of El Nino to a small measure in neighbouring areas, and it has, at least once in the past (1997), delivered admirably on this potential.

While the El Nino is already firmly established in the Pacific Ocean this year, the IOD is still in the neutral phase. "The Indian Ocean Dipole is currently neutral. All international climate models surveyed by the Bureau suggest a positive IOD event may develop in the coming months," Australia's Bureau of Meteorology noted in its latest update on IOD.

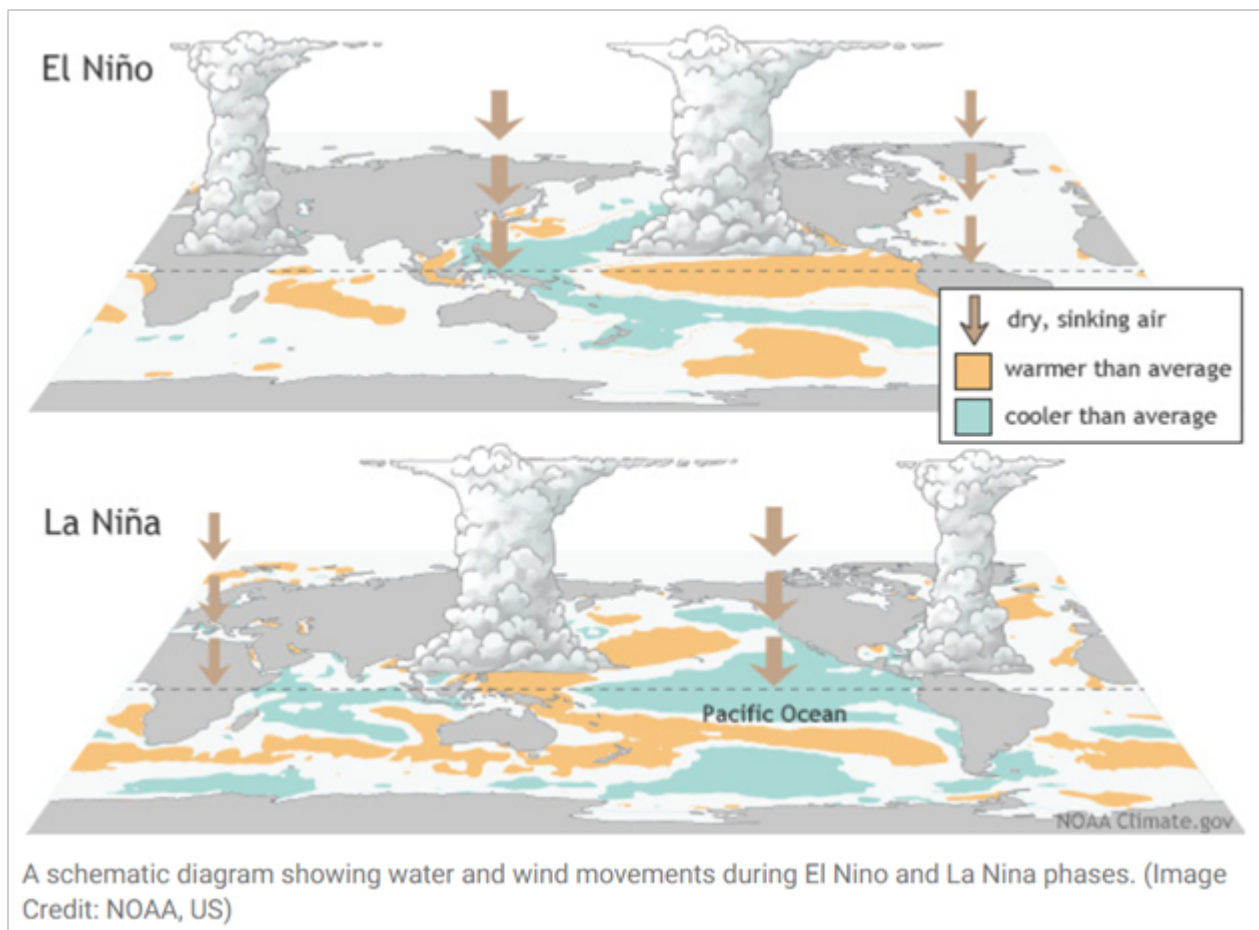
The India Meteorological Department (IMD), in its bulletin earlier this month, said there was an 80% chance of a positive IOD in the coming months. "The probability forecast for IOD indicates about 80% probability for positive IOD conditions and 15% of a neutral IOD during June-August 2023 season,"

## The Indian Nino

**Kamaraj IAS Academy**

Plot A P.127, AF block, 6 th street, 11th Main Rd, Shanthi Colony, Anna Nagar, Chennai, Tamil Nadu 600040

Phone: **044 4353 9988 / 98403 94477** / Whatsapp : **09710729833**



In a normal year, the eastern side of the Pacific Ocean, near the northwestern coast of South America, is cooler than the western side near the islands of Philippines and Indonesia.

This happens because the prevailing wind systems that move from east to west sweep the warmer surface waters towards the Indonesian coast.

The relatively cooler waters from below come up to replace the displaced water. An El Niño event is the result of a weakening of wind systems that leads to lesser displacement of warmer waters. This results in the eastern side of the Pacific becoming warmer than usual. During La Niña, the opposite happens.

Both these conditions, together called El Niño Southern Oscillation or ENSO, affect weather events across the world. Over India, the El Niño has the impact of suppressing monsoon rainfall.

IOD, sometimes referred to as the Indian Niño, is a similar phenomenon, playing out in the relatively smaller area of the Indian Ocean between the Indonesian and Malaysian coastline in the east and the African coastline near Somalia in the west.

One side of the ocean, along the equator, gets warmer than the other. IOD is said to be positive when the western side of the Indian Ocean, near the Somalia coast, becomes warmer than the eastern Indian Ocean. It is negative when the western Indian Ocean is cooler.

## ENSO and IOD

The IOD was identified as an independent system only in 1999. The air circulation in the Indian Ocean basin moves from west to east, that is from the African coast towards the Indonesian islands, near the surface, and in the opposite direction at the upper levels.

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That means the surface waters in the Indian Ocean get pushed from west to east. In a normal year, warmer waters in the western Pacific near Indonesia cross over into the Indian Ocean and make that part of the Indian Ocean slightly warmer. That causes the air to rise and helps the prevailing air circulation.

In the years when the air circulation becomes stronger, more warm surface waters from the African coast are pushed towards the Indonesian islands, making that region warmer than usual. This caused more hot air to rise and the cycle reinforces itself. This is the state of negative IOD

The opposite case involves air circulation becoming slightly weaker than normal. In some rare cases, the air circulation even reverses direction. The consequence is that the African coast becomes warmer while the Indonesian coastline gets cooler.

A positive IOD event is often seen developing at times of an El Nino, while a negative IOD is sometimes associated with La Nina. During El Nino, the Pacific side of Indonesia is cooler than normal because of which the Indian Ocean side also gets cooler.

That helps the development of a positive IOD. Many studies suggest that IOD events are actually induced by ENSO. However there is evidence to show that IOD events can have an independent existence.

While external factors such as ENSO can trigger IOD in some cases, the phenomenon, many times, is caused by local circulations or subsurface processes within the equatorial Indian Ocean. Even when triggered by external drivers, IOD events largely develop and mature through internal dynamics. Interestingly, when both IOD and ENSO are strong, their circulation patterns can impact each other

### **IOD impacts**

A positive IOD helps rainfall along the African coastline and also over the Indian sub-continent while suppressing rainfall over Indonesia, southeast Asia and Australia. The impacts are opposite during a negative IOD event.

Compared to ENSO events, the impacts of IODs are much weaker. But hope lingers, including this year when a strong El Nino is expected to develop in the Pacific Ocean.

IOD events usually originate in the months of April and May. However, there is an example of a strong IOD event developing late as well.

The year 2019 was a case where the IOD event developed during late monsoon, but was so strong that it compensated for the deficit rainfall during the first month of the monsoon season (June had 30% deficiency that year). The deficit in June that year was also attributed to a developing El Nino but that fizzled out later